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Using Hospital Anxiety and Depression Scale (HADS) on patients with epilepsy: Confirmatory factor analysis and Rasch models

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ABSTRACT

Purpose: The problems of mood disorders are critical in people with epilepsy. Therefore, there is a need to validate a useful tool for the population. The Hospital Anxiety and Depression Scale (HADS) has been used on the population, and showed that it is a satisfactory screening tool. However, more evidence on its construct validity is needed.
Method: A total of 1041 people with epilepsy were recruited in this study, and each completed the HADS. Confirmatory factor analysis (CFA) and Rasch analysis were used to understand the construct validity of the HADS. In addition, internal consistency was tested using Cronbachs' α, person separation reliability, and item separation reliability. Ordering of the response descriptors and the differential item functioning (DIF) were examined using the Rasch models.
Results: The HADS showed that 55.3% of our participants had anxiety; 56.0% had depression based on its cutoffs. CFA and Rasch analyses both showed the satisfactory construct validity of the HADS; the internal consistency was also acceptable ($\alpha = 0.82$ in anxiety and 0.79 in depression; person separation reliability = 0.82 in anxiety and 0.73 in depression; item separation reliability = 0.98 in anxiety and 0.91 in depression). The difficulties of the four-point Likert scale used in the HADS were monotonically increased, which indicates no disordering response categories. No DIF items across male and female patients and across types of epilepsy were displayed in the HADS.
Conclusions: The HADS has promising psychometric properties on construct validity in people with epilepsy. Moreover, the additive item score is supported for calculating the cutoff.

1. Introduction

People with epilepsy are in high risk of having mood disorders: up to 55% of people with refractory epilepsy may have depression [1,2]. A study even found that the prevalence of people with refractory temporal lobe epilepsy having psychiatric disorders up to 70% [3]. Due to the high prevalence of mood disorders, people with epilepsy showed a higher suicide rate (12%) than the general population (~1%) [4]. As a result, measuring the mood disorder in terms of anxiety and depression is a critical topic for clinicians [5].

In order to tackle the mood disorder issues in people with epilepsy, some researchers claim the importance of validating useful screening instruments [2,6]. They finally suggested that Neurological Disorders Depression Inventory for Epilepsy (NDDI-E) [7,8], Hospital Anxiety and Depression Scale (HADS) [9], and Beck Depression Inventory (BDI) [10] are useful to screen depression for people with epilepsy. Some studies also showed that HADS is a promising tool to assess the depression for people with epilepsy [11–13], and the benefit of using HADS is that the instrument has no items relating to somatic symptoms, a confounder to the diagnosis [2].

However, the knowledge of using HADS on people with epilepsy seems to be insufficient in its psychometric evaluation. Specifically, all studies only focus on the ability of screening depression [2,8,11–13]. Therefore, we do not have the full picture of the psychometric properties for HADS on people with epilepsy, such as the construct validity and internal consistency. Also, we do not know whether the HADS has the ability to assess anxiety for people with epilepsy. For example, we do not know whether the descriptors of the

Abbreviations: HADS, Hospital Anxiety and Depression Scale; CFI, confirmatory factor analysis; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual; SEM, structural equation model; TLI, Tucker–Lewis index; infit, information-weighted fit statistic; MnSq, mean square; outfit, outlier-sensitive fit statistic.

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response are appropriate; and whether male and female patients interpret the HADS similarly.

In addition to the traditional methods, Rasch analysis is an alternative to test psychometric properties of an instrument. The simplest Rasch uses a logistic equation ($Pi = [\exp(\theta - bi)]/[1 + \exp(\theta - bi)]$, where Pi denotes the probability of correct answer on item i, and bi denotes the item difficulty) [14] to estimate the underlying ability of a respondent, and the difficulty of each item. Other extensions of the Rasch analysis have been developed for different response scales (e.g., the ordinal and interval scales) [15,16]. Although Rasch analysis is not a statistical technique that the clinicians are familiar with [17], the benefits of using it include (a) separately estimating person ability and item difficulty; (b) assessing whether different groups interpret the same item in different ways; (c) testing the item validity and the unidimensionality of the entire instrument; (d) investigating the appropriateness of the response descriptors [18,19]. Therefore, some articles [20,21] suggest applying Rasch models along with traditional psychometric methods to examine the reliability and validity of an outcome instrument.

The aim of this study was to examine the construct validity and internal consistency of the HADS using advanced psychometric methods. Confirmatory factor analysis (CFA) and Rasch models were used to investigate the construct validity. Additional tests related to Rasch models were adopted to understand the appropriateness of the response descriptors and to examine the interpretation on HADS between male and female patients.

2. Methods

2.1. Participants and procedure

The study participants were epileptic patients who were referred to six neurologic centers in Tehran and Qazvin from July 2015 to through October 2015. The study measure was administrated by a trained nurse. Eligibility criteria included confirmed diagnosis of epilepsy by neurologist and being able to read and write Persian. Patients were excluded from the study if they had intellectual disability, cognitive impartment and did not agree to complete informed consent. The study protocol was approved by the research ethics committee of the Qazvin University of Medical Sciences. All participants gave their written informed consent.

2.2. Hospital Anxiety and Depression Scale (HADS)

Zigmond and Snaith [9] developed the 14-item HADS to measure the anxiety (7 items) and depression (7 items) of patients with both somatic and mental problems. The response descriptors of all items are *Yes, definitely* (score 3); *Yes, sometimes* (score 2); *No, not much* (score 1); *No, not at all* (score 0); except for items 7 and 10, which are scored reversely. A higher score represents higher levels of anxiety and depression: a domain score of 11 or greater indicates anxiety or depression; 8–10 indicates borderline case; 7 or lower indicates no signs of anxiety or depression. The two-factor framework of the HADS has been supported in cancer patients [22], HIV patients [23], and a general population of Norway [24]. The internal consistency of was good in both domains (0.80 in anxiety and 0.76 in depression) [24]. Moreover, the Iranian version of HADS has linguistic validity, acceptable internal consistency (0.78 in anxiety and 0.86 in depression), and satisfactory known-group validity (significant differences were found in different stages of cancer patients) [25].

2.3. Data analysis

Demographics of the participants were described using mean, SD, and frequency. In addition, we used three CFAs to examine the construct validity of the HADS: two one-factor models and one two-correlated-factor model. The one-factor models respectively had the latent construct of anxiety and depression, while the two-correlated-factor model simultaneously adopted the two constructs (anxiety and depression). Because the HADS is rated on a four-point Likert scale, we used diagonally weighted least squares (DWLS) estimator rather than using maximum likelihood (ML) estimator in the CFA. Moreover, we used the following cutoffs in different fit indices to determine an acceptable model: normed χ^2 (i.e., χ^2 value divided by the degrees of freedom) <3, comparative fit index (CFI) and Tucker–Lewis index (TLI) >0.95, root mean square of error approximation (RMSEA) and standardized root mean square residual (SRMR) <0.08 [26–29]. Rasch analyses were also used to test the construct validity in terms of unidimensionality of the HADS. Specifically, two rating scale models (RSM) were adopted: one for anxiety and another for depression. Two statistics, information-weighted fit statistic (infit) mean square (MnSq) and outlier-sensitive fit statistic (outfit) MnSq, were used to test the item fit. An item with infit or outfit MnSq out of the 0.5–1.5 range is misfit [21]. In addition to the construct validity, internal consistency of the HADS was also examined using classical test theory (i.e., Cronbach's α) and Rasch models (i.e., separation reliability), and acceptable value for internal consistency is >0.7 [19].

Based on Rasch analysis, each item has a difficulty value that suggests how hard/easy for the respondents to fulfill the item description. Also, each response descriptor has different difficulties, and we anticipated the difficulty increased by the rating score (i.e., score 3 is harder than score 2, score 2 is harder than score 1 to fulfill each item description, and so on). Therefore, we used the average and step measures of the descriptors to determine whether disordering threshold exists in the HADS. In addition to the monotonically increased difficulties, infit and outfit MnSq within 0.5 and 1.5 suggest no disordering [30]. Finally, we tested the differential item functioning (DIF) across gender. We used both statistical test and DIF contrast (the difficulty for male minus the difficulty for female) to understand whether male patients with epilepsy interpret any HADS items differently from the female patients, and a DIF contrast >0.5 indicates a substantial DIF [31]. That is, male and female patients interpret the same item in different ways. We also tested the DIF across two types of epilepsy (generalized vs. localization related).

Demographics were analyzed using SPSS 17.0 (SPSS Inc., Chicago, IL, USA); CFAs using lavaan package in the R software [32]; Rasch models using WINSTEPS [33].

3. Results

Table 1 also shows the demographic information and the clinical characteristics of the participants; specifically, the mean (SD) age of the participants was 39.1 (7.0) years with a mean educational year of 5.1 (1.2). Although all the patients filled out the HADS, some reported missing values: 42 did not fully answer the anxiety domain of the HADS; 47 did not fully answer the depression domain of the HADS. Because the number of patients with missing values was little ($<5\%$), their HADS data were excluded in both CFA and Rasch models. Of those who ($n = 999$) had fully answered the anxiety domain of the HADS (response rate = 96.0%), 33.8% ($n = 352$) had anxiety and 21.5% ($n = 224$) were borderline case based on the suggested cutoff. Of those who ($n = 994$) had fully answered the depression domain of the HADS

Table 1
Participant characteristics.

	Mean or n	SD or %
Age (year)	39.1	7.0
Seizure frequency in the past year	10.8	8.19
Disease duration (years)	23.94	13.89
Gender		
Male	451	43.3%
Female	590	56.7%
Educational year	5.1	1.2
Currently smoking (yes)	321	30.8%
Currently drinking (yes)	307	29.5%
Marital status		
Single	235	22.6%
Married	778	74.7%
Widowed	28	2.7%
Economic status		
Very good	12	1.2%
Good	152	14.6%
Neutral	643	61.8%
Bad	181	17.4%
Very bad	53	5.1%
Epilepsy type		
Generalized	380	36.50%
Localization related	593	56.96%
Not defined	68	6.53%

(response rate = 95.5%), 21.9% (n = 228) had depression and 24.9% (n = 259) were at the borderline based on the suggested cutoff.

CFA results revealed that all proposed models (i.e., two one-factor models and a two-correlated-factor model) were all satisfactory or close to acceptable in the data-model fit indices, including the normed χ^2 (0.83–3.57), CFI (0.985–1.000), TLI (0.982–1.000), RMSEA (0.000–0.052), and SRMR (0.021–0.059) (Table 2); factor loadings were all significant and >0.3 in the two-correlated-factor model (Table 3). In addition, the internal consistency was good in both domains whether using classical test theory ($\alpha = 0.82$ in anxiety and 0.79 in depression) or separation reliability in Rasch models (person separation reliability = 0.82 in anxiety and 0.73 in depression; item separation reliability = 0.98 in anxiety and 0.91 in depression). Moreover, all items, which difficulties were from −0.77 to 0.55 in anxiety and −0.17 to 0.26 in depression, had fit well in their embedded latent constructs as the infit and outfit MnSq all fell between 0.5 and 1.5 (Table 3).

The difficulties of the responses (i.e., the four-point Likert scale) were monotonically increased in both average and step measures for both anxiety and depression domains. In addition, the infit and outfit MnSq were all fell between 0.5 and 1.5 (Table 4), and suggested no threshold disordering. As for DIF testing, our results showed that there were no DIF items across male and female patients; and across two types of epilepsy as all DIF contrasts were less than 0.5 and nonsignificant (Table 5).

4. Discussion

Our results showed that HADS has promising psychometric properties in terms of the construct validity and internal consistency in people with epilepsy. Although many studies have found that HADS has satisfactory construct validity using

Table 2
Confirmatory factor analysis (CFA) results.

Fit indices	Models		
	One factor: Anxiety	One factor: Depression	Two-correlated-factor
χ^2 (*df*)	37.675 (14)	11.661 (14)	270.981 (76)
Normed χ^2	2.69	0.83	3.57
CFI	0.994	1.000	0.985
TLI	0.991	1.000	0.982
RMSEA (95%CI)	0.041 (0.026, 0.057)	0.000 (0.000, 0.026)	0.052 (0.045, 0.058)
SRMR	0.040	0.021	0.059

Normed $\chi^2 = \chi^2$ divided by *df*.
CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root mean square of error approximation; SRMR = standardized root mean square residual; CI = confidence interval.

Table 3
Standardized factor loadings in confirmatory factor analysis (CFA) and Rasch difficulties and fit statistics for each item.

Domain	CFA	Rasch		
Items description	Loadings[a]	Difficulties	Infit MnSq	Outfit MnSq
Anxiety				
1. I feel tense or wound up	0.534	−0.15	1.31	1.32
3. I get a sort of frightened feeling as if something awful is about to happen	0.781	0.52	1.03	1.03
5. Worrying thoughts go through my mind	0.626	−0.77	1.11	1.13
7. I can sit as ease and feel relaxed	0.767	−0.15	0.79	0.80
9. I get a sort of frightened feeling like 'butterflies' in the stomach	0.586	−0.21	0.97	0.95
11. I feel restless as if I have to be on the move	0.786	0.21	0.75	0.75
13. I get sudden feelings of panic	0.596	0.55	1.03	1.00
Depression				
2. I still enjoy the things I used to enjoy	0.594	−0.17	0.72	0.77
4. I can laugh and see the funny side of things	0.710	0.26	0.66	0.68
6. I feel cheerful	0.793	−0.10	0.71	0.72
8. I feel as if I am slowed down	0.731	−0.10	0.99	0.97
10. I have lost interest in my appearance	0.498	−0.06	1.34	1.33
12. I look forward with enjoyment to things	0.380	0.24	1.14	1.13
14. I can enjoy a good book or TV program	0.494	−0.06	1.44	1.43

Infit = information-weighted fit statistic; Outfit = outlier-sensitive fit statistics; MnSq = mean square.
[a] Loadings are derived from two-correlated-factor model.

Table 4
Response disordering tests.

	Average measure	Step measure	Infit MnSq	Outfit MnSq
Anxiety				
0	−3.66	–	1.15	1.11
1	−1.10	−2.53	0.90	0.91
2	1.28	0.39	0.85	0.83
3	3.35	2.13	1.11	1.15
Depression				
0	−2.85	–	1.08	1.07
1	−0.83	−1.64	0.90	0.92
2	0.89	0.17	0.94	0.94
3	2.73	1.47	1.03	1.06

0: *No, not at all*; 1: *No, not much*; 2: *Yes, sometimes*; 3: *Yes, definitely.*
Scores of items 7 and 10 were reversely coded.
Infit = information-weighted fit statistic; Outfit = outlier-sensitive fit statistics; MnSq = mean square.

exploratory factor analysis or CFA [22–24], their populations were not people with epilepsy, and our study seems to be the first on the population. Also, the importance of using HADS on people with epilepsy has been noticed, and several studies [2,8,11–13] test the psychometric properties of HADS on the population. However, to the best of our knowledge, no studies have used CFA or Rasch models. Also, we elaborated the issues of response descriptors and DIF for HADS in people with epilepsy, and found that HADS has adequate response descriptors and no DIF items. The aforementioned issues have never been tackled for HADS in population with epilepsy.

Previous studies examining psychometric properties of HADS on people with epilepsy emphasize the cutoffs and its predictive ability for screening depression [2,11–13]. The cutoff information is important for clinicians to make clinical decision; however, we feel that ensuring all the items on HADS embedded in their belonging construct is the major assumption to test the cutoffs. If some items do not have acceptable construct validity, the cutoffs for screening may be biased; that is, those items without acceptable construct validity should not be included for calculation cutoffs. Therefore, our results support previous studies using all item scores in depression domain of HADS to decide the cutoffs [2,11–13].

Another important assumption for using all HADS item scores to determine the cutoffs is the ordered response descriptors. Our results suggest that all response descriptors were in order, and support the use of cutoffs explored by previous studies [2,11–13]. In practical use, summing up the item scores is the most feasible and efficient method to evaluate the performance of an individual. However, an assumption should be fulfilled before summing up the item scores; that is, the item score is coherent to its descriptor. For example, if a patient interprets the severity of score 2 descriptor being less than or equal to that of score 3, then, the summated score would be biased. In other words, we need to ensure that the severity of score 3 being greater than that of score 2; score 2 greater than score 1; score 1 greater than score 0. Then, the summated cutoffs could be meaningful. Apparently, no studies have noticed the assumption for the HADS, and we seemed to be the first to examine the order of response descriptors. Nevertheless, our results revealed the appropriateness of summing up the score, and the assumption is fulfilled for the HADS.

In addition to the depression, we extended the use of HADS to anxiety for people with epilepsy. Although only a few studies discussed the anxiety for people with epilepsy [34–37], the topic should not be ignored because anxiety also impacts an individual's quality of life [34]. Our results suggest that all items of HADS on anxiety domain had satisfactory construct validity, and future studies may want to further use the items in anxiety domain to develop the cutoffs for screening.

In addition, the interpretations of item descriptions in HADS between genders should be investigated. If females and males interpret an item description in different ways, it means that the item is unfair to measure the score of the latent construct [20,38]. Therefore, a good item should display no DIF across genders, and our results showed that all HADS items had no DIF across male and female patients. Similarly, a study [39] on a general population of North East Scotland found almost no DIF items in HADS across gender, except for item 11 (*I feel restless as if I have to be on the move*). Nevertheless, we agree with Cameron et al. [39] that using HADS across gender is appropriate. We further demonstrated that using HADS across types of epilepsy (generalized and localization related epilepsies) is appropriate.

The study has some limitations. First, all patients were recruited only from two cities. It is possible that more severe patients had been referred to other cities, and the generalizability of our results is somewhat limited. Second, this study did not assess the associations between anxiety, depression, and socio-clinical variables. That is, in this current study, we did not have a gold standard to help us determine the concepts of the HADS are on anxiety and depression. Although previous evidence has showed that the HADS is well correlated with other gold standards (e.g., DSM-IV), we did not have such information in the current study.

Table 5
Differential item functioning (DIF) across gender and across types of epilepsy.

Item #	Difficulty in gender		DIF contrast	Difficulty in epilepsy type		DIF contrast
	Male	Female		Generalized	Localization related	
Anxiety						
1. I feel tense or wound up	−0.12	−0.17	0.05	−0.15	−0.15	0.00
3. I get a sort of frightened feeling as if something awful is about to happen	0.47	0.56	−0.09	0.59	0.52	0.07
5. Worrying thoughts go through my mind	−0.73	−0.80	0.07	−0.77	−0.79	0.02
7. I can sit as ease and feel relaxed	−0.19	−0.12	−0.07	−0.15	−0.15	0.00
9. I get a sort of frightened feeling like 'butterflies' in the stomach	−0.29	−0.15	−0.15	−0.24	−0.19	−0.05
11. I feel restless as if I have to be on the move	0.29	0.14	0.15	0.21	0.24	−0.03
13. I get sudden feelings of panic	0.55	0.55	0.00	0.55	0.55	0.00
Depression						
2. I still enjoy the things I used to enjoy	−0.17	−0.17	0.00	−0.05	−0.22	0.17
4. I can laugh and see the funny side of things	0.22	0.28	−0.06	0.29	0.22	0.07
6. I feel cheerful	−0.10	−0.10	0.00	−0.07	−0.10	0.03
8. I feel as if I am slowed down	0.01	−0.17	0.18	−0.10	−0.10	0.00
10. I have lost interest in my appearance	0.03	−0.13	0.16	−0.13	−0.01	−0.12
12. I look forward with enjoyment to things	0.16	0.29	−0.13	0.17	0.27	−0.10
14. I can enjoy a good book or TV program	−0.13	−0.02	−0.11	−0.11	−0.06	−0.05

DIF contrasts = Difficulty in male–difficulty in female, and all DIF contrasts were nonsignificant.

Therefore, we were unable to demonstrate the relationship between HADS and other gold standards. Third, although our results demonstrate the DIF across gender and two types of epilepsy (generalized vs. localization related); clinicians and researchers should note that we did not examine DIF across other significantly clinical or demographic characteristics (e.g., patients with well controlled or refractory epilepsies; patients with mesial temporal lobe epilepsy related to hippocampus sclerosis, patients with absence or myoclonic juvenile epilepsy). The HADS items are possibly to be interpreted differently across these important characteristics; however, we did not have such information to test the DIF. Future studies are warranted to elaborate the DIF issue across these significant demographics for people with epilepsy.

In conclusion, HADS has sound psychometric properties in people with epilepsy. Summing up the item scores is appropriate as the response descriptors were scored in order and all items were valid. Because all items were valid in both CFA and Rasch models, we suggest that using all the items to measure anxiety and depression for people with epilepsy is suitable. However, future studies may want to explore more in the anxiety domain of HADS for people with epilepsy because most studies only focus on the depression domain.

Conflict of interest statement

All the authors declare that there is no conflict of interest.

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